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CERTIFICATE

This certificate is issued in support of an application for Patent registration in a country outside New Zealand pursuant to the Patents Act 1953 and the Regulations thereunder.

I hereby certify that annexed is a true copy of the Provisional Specification as filed on 20 September 2002 with an application for Letters Patent number 521541 made by BRENT FELIX JURY.

Dated 29 September 2003.

Neville Harris

Neville Harris
Commissioner of Patents, Trade Marks and Designs

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PATENTS ACT 1953

PROVISIONAL SPECIFICATION

APPARATUS FOR AND METHODS OF TESTING AND STRESS RELIEVING METAL COMPONENTS

I, BRENT FELIX JURY, a New Zealand citizen of 158 Mahoetahi Road, RD42, Waitara, New Zealand, do hereby declare this invention to be described in the following statement:

This invention relates to improvements in and relating to devices and apparatus for testing and stress relieving metal components, and methods associated thereto.

Metal components suffer from a degree of residual stress caused by actions such as mechanical or thermal loading. The presence of stress affects the physical properties of a metal component and can result in stress fatigue and even failure of a component.

One such metal component is a railway line. Railway lines undergo thermal cycling. A railway line is therefore generally laid under a neutral load condition at a predetermined temperature. However, sections of railway lines can be under compression or tension over time when being subject to repeated thermal cycles. If railway lines are not tested at regular intervals, particularly in harsh environments experiencing large temperature changes, undesirable movements in the railway line can occur, and even buckling may result. Extreme buckling in a line can derail a train.

It is an object of the invention to provide a device and/or an apparatus for testing the integrity of metal components and/or stress relieving a railway line that overcomes at least some of the abovementioned problems, or at least to provide the public with a useful choice.

It is a further object of the invention to provide a method of testing the integrity of metal components that overcomes at least some of the abovementioned problems, or at least to provide the public with a useful choice.

It is yet a further object of the invention to provide a system for testing a railway line that overcomes at least some of the abovementioned problems, or at least to provide the public with a useful choice.

According to a first broad aspect of the invention there is provided a tuning device configured and arranged to obtain an improved electromagnetic signal, the tuning

device including an elongate member attachable at one end to the metal component being tested or to a material coupled to the metal component being tested, and wherein the tuning device is adapted at the other end to receive a signal measuring means.

Desirably the signal measuring means is a transducer means. Preferably the transducer means is an accelerometer.

Desirably the device is made of a metal. Preferably the metal is a non brittle, high tensile, material. Advantageously the metal has sufficient elasticity and is ductile.

According to a second broad aspect of the invention there is provided an apparatus for testing the integrity of a metal component, the apparatus including a tuning device in accordance with a first aspect of the invention being attachable to a railway line or being coupled to a railway line to be tested wherein, in use, the apparatus generates a signal reflecting the frequency response of the railway line and the signal measuring means measured the vibration frequencies of the line.

Desirably the base member is clamped to the line. Advantageously the base member is clamped to the outside of the line. Preferably the elongate member is, in use, positioned parallel with the railway line.

According to a third broad aspect of the invention there is provided an apparatus for testing the integrity of a metal component comprising a vibration means, control means, frequency of vibration measuring means and an amplitude of vibration measuring means, the vibration means being associated with a said metal component, in use, to directly vibrate a metal component, the control means controlling the frequency of vibration and to control measurements of the amplitude of vibration and frequency of vibration of the said metal component.

Preferably the metal component is a section of railway line. Advantageously the velocity amplitude is sensed by an accelerometer.

According to a fourth broad aspect of the invention there is provided a method of testing and/or stress relieving a section of railway line or pipeline comprising the steps of:

a. attaching a vibration means to a metal component to provide a substantially direct vibration couple between the vibration means and the metal component;

b. attaching an amplitude of vibration measurement means at a sufficient distance from the vibration means; and

c. actuating the vibration means at above or below the resonance frequency of the metal component and adjusting the frequency to determine whether the metal component is in compression or tension.

Preferably in step c. the vibration means is actuated at a frequency below the resonance frequency of the metal component.

Desirably in step b. the amplitude of vibration measurements are obtained using a tuning means or arrangement.

Desirably the metal component is a section of railway line.

According to a fifth broad aspect of the invention there is provided a system of testing the integrity of a railway line, the system uses the apparatus of the third aspect of the invention, and wherein a section of railway line is over or about five adjoining or consecutive railway sleepers, the transducer being coupled to the railway line above the second sleeper, the tuning means being coupled to the railway line above the third sleeper and the vibration means being coupled to the railway line above the fourth sleeper.

Advantageously the second, third and fourth sleepers are unclipped from the railway lines during testing. Desirably a packing member in the form of a shim can be positioned between the top of the second sleeper and the underside of the railway line and/or between the top of the fourth sleeper and the underside of the railway line.

According to a sixth broad aspect of the invention there is provided a computer processing steps for controlling the operation of the apparatus for testing the integrity of a railway line, the steps including:

(i) obtaining data on the frequency of vibration of the line, the amplitude of vibration of the line, and the temperature of the line;

(ii) plotting a graph showing the amplitude of vibration against the frequency of vibration at a determined temperature of the line; and

(iii) recording the resultant data for comparison purposes.

Preferably the computer processing steps further include step (iv) of comparing the plots for a section of line being tested at different line temperatures and determining whether the line is in compression or tension.

Desirably the processing steps included the preliminary step of obtaining a reference measurement of the velocity amplitude of the line when in a neutral position defined as being neither in compression or tension. This measurement can be recorded for comparison purposes for all plots at different line temperatures.

The invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1: illustrates a block diagram of general components of the apparatus of the invention;

Figure 2:	illustrates the system of attachment of the apparatus of the invention to a section of railway line;
Figure 3:	illustrates the tuning arrangement; and
Figure 4:	illustrates the attachment of the tuning system to a railway line.

Referring to figure 1, a block diagram of general components of the apparatus of the invention, generally referred to as 1, is illustrated.

The apparatus 1 can be provided to test the integrity of a metal component. The metal component can desirably be a section of railway line. It will be appreciated that references herein to a railway line can also be references to other metal components, including pipelines. However, for simplicity of description of the invention the embodiments will only refer to railway lines as the metal components being tested.

The apparatus 1 can include a control means 2 in the form of a microprocessor programmed to control the operation of the apparatus and gather data for display and/or storage purposes. With respect to storage purposes the data may be manipulated to provide statistical data showing characteristics of the metal component being tested.

The control means 2 can function to control each step of the method of the invention. The control means 2 can desirably be powered by a battery for remote testing and to allow the apparatus to have portable applications rather than laboratory work bench applications.

A vibration means 3 can be mounted by known means, such as for example a clamp, to the railway line. Desirably vibrations are generated by a motor adapted with vibration inducement means to apply force to the line. Such force is adjustable such that the frequency of vibration can be changed as required. The vibration means 3

(otherwise known as an exciter or shaker) can therefore be controlled by controlling the speed of the motor. The motor can be controllable by the control means 2.

The motor speed of the vibration means can be sensed using a tachometer 4, and such signal is fed to the control means 2.

The amplitude of vibration induced on the line can be sensed and measured using a signal measuring means in the form of a transducer means, desirably an accelerometer 5. It will be appreciated that any suitable known instrument may be applied.

The accelerometer 5 generates an electrical signal in response to the vibration acceleration of the railway line as induced by the vibration means 3, and provides a signal that is fed to the control means 2.

A temperature measurement means 6 with a suitably sensitive sensing means can measure the temperature of the line during measurements. The temperature measurements means 6 provides a signal to the control means 2 that allows the temperature of the line to be tagged against other recorded data at the time of testing.

A display means 7 can be provided to display the plotted measurements of velocity amplitude (for example, in mm/second) against the frequency of vibration and any other desirable characteristics of the data obtained in the testing phase of the operation.

Referring now to figure 2, a system of attachment of the apparatus to a section of railway line before testing of the line is commenced, is illustrated.

It will be appreciated by persons skilled in the art that railway lines undergo constant compression or tension caused by changes to temperature about the line and other factors. Rapid changes in temperature or unacceptably high or low temperatures can induce undesirable levels of stress that can cause railway lines to buckle.

Some railway lines are joined in sections. Adjoining sections of line must be laid at a similar level of tension or compression, and can be desirably laid at a neutral state at a certain temperature. If adjoining sections are in a substantially different state and temperature fluctuations are rapid, buckling or other undesirable movements in the line can occur. The invention can assist with testing the integrity of railway lines to determine whether relaying or replacement of sections of line is required, and may provide an aid to the proper laying or relaying of railway lines.

A section of railway line 10 for testing is seen in figure 2 can be resting on five railway sleepers, defined as the first sleeper A, the second sleeper B, the third sleeper C, the fourth sleeper D, and the fifth sleeper E. These five sleepers can be left clipped to the line to be tested or be unclipped. In the later case, these five sleepers can be unclipped from the line to be tested or may be left in position during testing. The first sleeper A and the fifth sleeper E can be preferably rigidly secured and having ballast compacted and in contact with the sides of the first sleeper A and the fifth sleeper E such that the underside of the sleepers A and E can be in contact with the ballast. It will be appreciated by one skilled in the art that ballast can also be used on other sleepers as required to ensure proper contact during testing.

The second sleeper B, the third sleeper C and the fourth sleeper D can be unclipped from the line 10. A packing member 11 in the form of a shim can be placed between the top of the second sleeper and the underside of the line 10. A shim 11 can also be placed between the top of the second sleeper and the underside of the line 10. A gap is advantageously left between the top of the third sleeper C and the underside of the line 10, generally indicated by 12.

The arrangement of the second, third and fourth sleepers relative to the line 10 can be considered important for the system of testing using the apparatus 1.

The accelerometer 3 can be mounted to the line 10 desirably above the fourth sleeper D. Alternatively the accelerometer 5 can be mounted in a tuning

arrangement as described below with reference to figures 3 and 4. The vibration means 3 can be coupled or mounted above the second sleeper B. The temperature measurement means 6 can be mounted in any suitable position on the line 10. All necessary data lines are connected to the control means 2 by hard wire or otherwise, such as, for example, infra red or laser signal.

In operation, a method of testing the integrity of the line 10 is described. The vibration means 3 is activated and the accelerometer 5 provides a feedback signal to the control means 2. The signal can be processed to a digital form and a display means 7 displays a plot of the velocity amplitude of vibration (mm/sec) against the frequency of vibration (hertz). The frequency of vibration can be increased, generally from within the 0 to 100hz range in some situations. A reasonably linear measurement of amplitude of vibration is measurable by the accelerometer 5 that can also be displayed. The vibration is increased until a noticeable spike is detected.

With some railway lines a spike or loading node may be detected between 50hz and 125hz. If the line is in tension the spike may be detected between 50hz and 75hz. If the line is in compression a noticeable spike is detectable at between about 85hz and 100hz. This information is useful for determining whether a section of railway line requires re-stretching or replacement and provide an indication of the condition of the line 10.

It will be appreciated that in one alternative embodiment, the accelerometer 5 may be placed between the sleeper C and sleeper D and the vibration means 3 mounted above the second sleeper B to allow desirable and accurate measurements to be obtained in accordance with the invention. The accelerometer 5 and the vibration means 3 should preferably be mounted at least 60 cm apart.

Referring now to figures 3 and 4, a tuning arrangement for obtaining an electrical signal representing the frequency of vibration on a railway line, generally referred to as 20, is illustrated.

The tuning arrangement 20 is designed to improve the quality of the signal by reducing errors caused by the standard clamping system incorporated with attaching or coupling an accelerometer directly to the railway line.

A base member 21 can be in the form of an L-cross section and functions to anchor directly or couple the signal measuring means or transducer means to the railway line 30. The base member 21 is large enough to allow a clamping means 22 to clamp the tuning arrangement to the line 30. As seen clearly in figure 4, desirably the base member 21 is clamped to the outside of the line 30 as it is considered to be an area of the line that does not wear to the same extent as the inside head section of a standard two rail line.

A tuning device 23 is made of any suitable and durable material, and functions to couple the transducer means in the form of an accelerometer 24 to the base member 21 and allow accurate measurements to be taken. A non-brittle elastic material can be suitable, and a high tensile mild metal is desirable, as it is tough and ductile. A light metal with a high elasticity can be advantageous.

The near end of the elongate member 32 can be located in a slot (not shown) in an edge of the base member 21 for increased coupling and attached to the base member 21 by any suitable attachment means. In this example a screw 25 is shown. The accelerometer 24 can be secured to the elongate member 23 at the distal end. A dampening means 26 may be included adjacent the accelerometer 24 at the distal end of the elongate member 23.

The dampening means 26 may desirably be in the form of a tubular dampener having a hollow section allowing a material to be added within to set the desired tuning frequency of the tuning arrangement. Desirably sand may be used in the dampener. The dampener may possibly be about 15 millimetres in height and about 3 millimetres in diameter. Other dimensions and shapes are envisaged within the scope of the invention.

In one non-limiting example, the tuning device 23 can be about 13.5 cm between the screw 25 and the accelerometer 24 and be about 16mm in width and about 3 mm in thickness. These dimensions may be provided when the tuning device is being used to measure frequencies at about 78hz or 80hz.

It may well be that a more sensitive tuning device 23 can be provided when the thickness of the device 23 is reduced.

It will be appreciated that when the base member 21 is clamped to the line the elongate member 23 can be parallel with the line.

In yet a further embodiment or set up arrangement for testing as an alternative to the previous methods as described with reference to figure 2, no shims or packing need be used, and the railway line 30 can remain clipped to the sleepers.

The vibration means 3 is located over sleeper B, and the base member 21 is clamped to the line between sleeper C and sleeper D. The coupled tuning device 23 and accelerometer 24 are positioned desirably at least 60 cm from the vibration means 3 to obtain more accurate results as interference from the vibration means 3 can be avoided.

Advantageously, the feedback signal from the accelerometer 5 to the control means 2 can be provided to the control means 2 via an infra red or laser signal means. The receiver for the infra red or laser signal may be attached to a rail car that is movable on the line, and wherein the testing and measuring apparatus of the invention is located.

It is considered that one desirable tuned frequency is 80hz as it is considered a suitable frequency for testing resulting in reasonable amplification of the velocity amplitude signals sensed by the accelerometer 24. This is bearing in mind that the resonant frequencies of many railway lines are well above this frequency.

The invention further includes suitable computer software for controlling the operation of the control unit 2. Preferably the computer processing steps for controlling the operation of the apparatus for testing the integrity of a railway line includes the steps of obtaining data on the frequency of vibration of the line by using a suitable measuring device such as a tachometer. It will be appreciated that close control of the vibration means is possible using the tachometer to sense motor speed and to provide a signal to the control unit 2. The control unit 2 may then provide a signal to adjust motor speed as appropriate.

The accelerometer 5 provides a signal of the amplitude of vibration of the line. The temperature measurement means 6 will provide a data signal of the temperature of the line.

Once this data has been obtained, the next step is executed in that a graph can be plotted showing the amplitude of vibration against the frequency of vibration at a determined temperature of the line. The resultant data is then recorded and can be later compared against other derived data as required.

Preferably the computer processing steps further include the step of comparing the plots for a section of line being tested at different line temperatures and determining whether the line is in compression or tension.

Desirably the processing steps included the preliminary step of obtaining a reference measurement of the velocity amplitude of the line when in a neutral position defined as being neither in compression or tension. This measurement can be recorded for comparison purposes for all plots at different line temperatures.

Wherein the foregoing description reference has been made to integers or components having known equivalents then such equivalents are herein incorporated as if individually set forth.

Although this invention has been described by a way of example of possible embodiments, it is to be appreciated that improvements and/or modifications may be made thereto without departing from the scope of the present invention.

BRENT FELIX JURY
By his Attorneys
SCHUCH & COMPANY
Per:

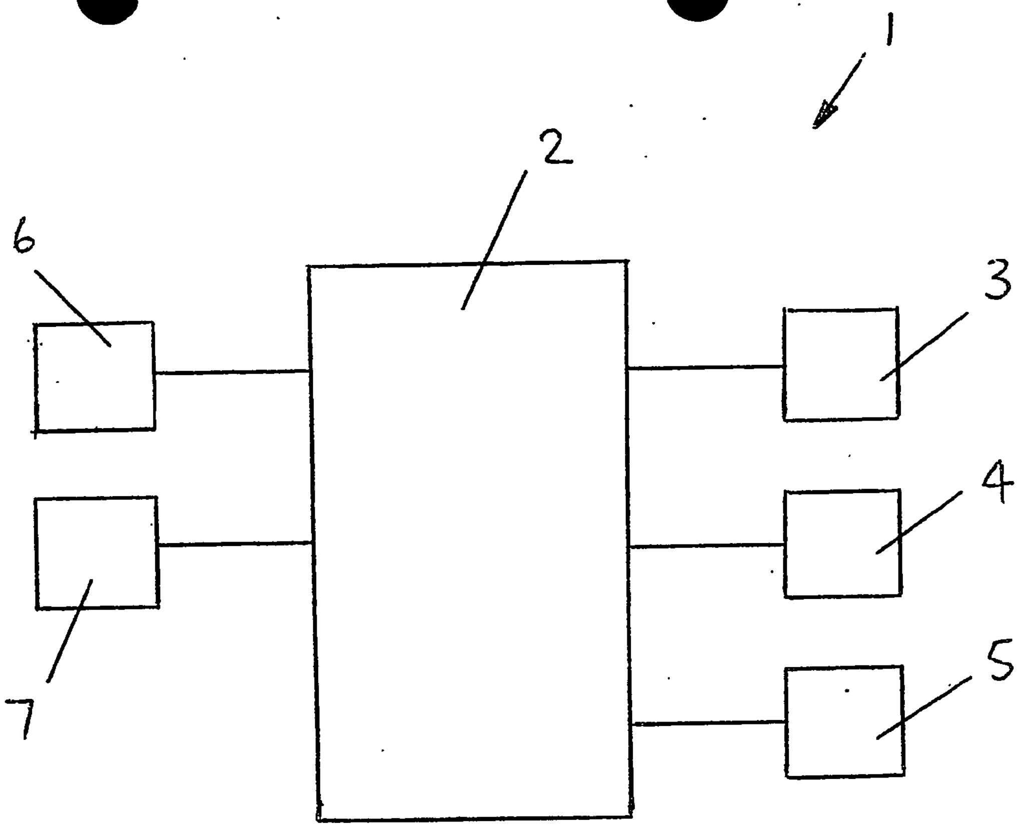

Figure 1

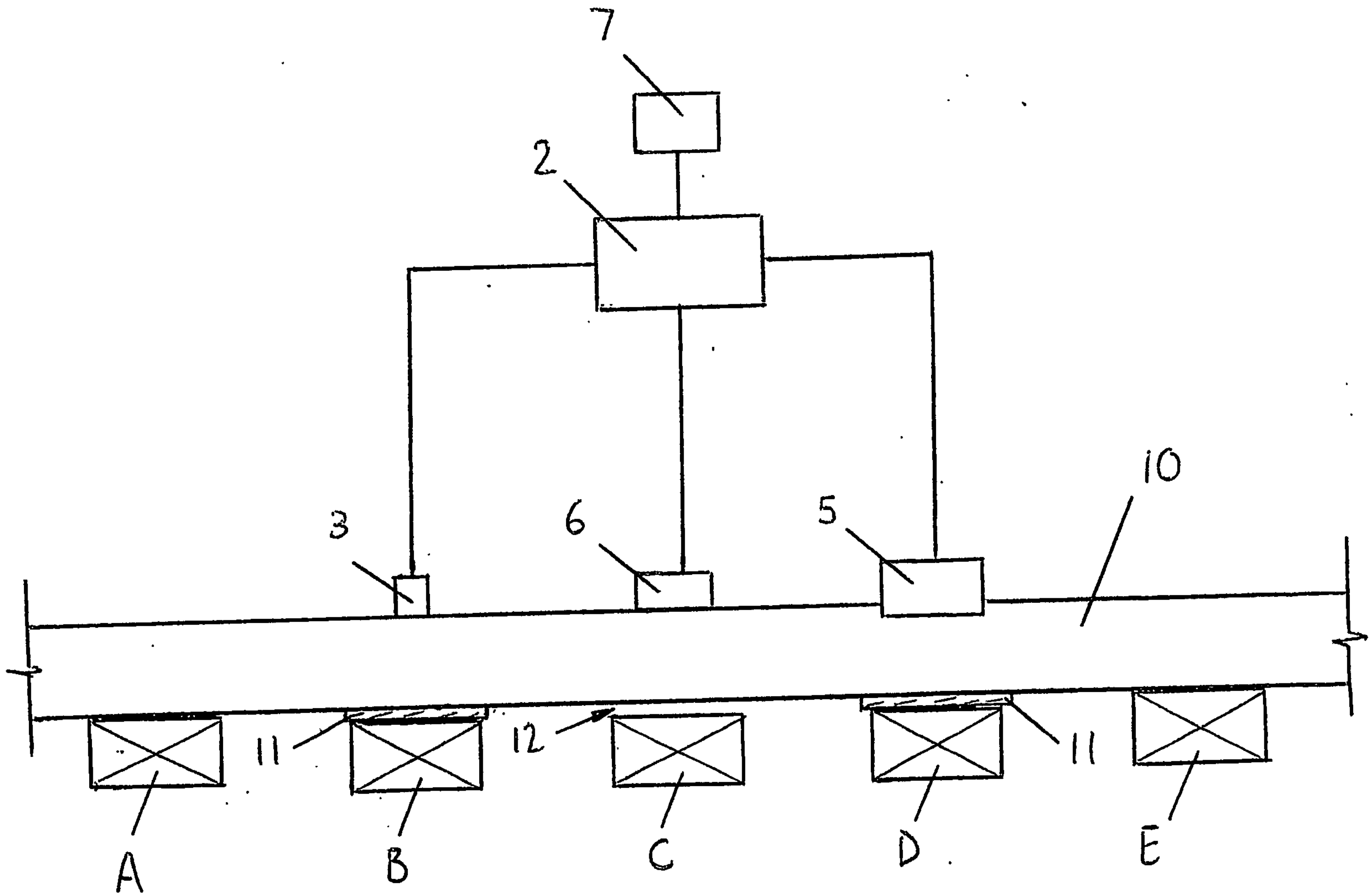

Figure 2

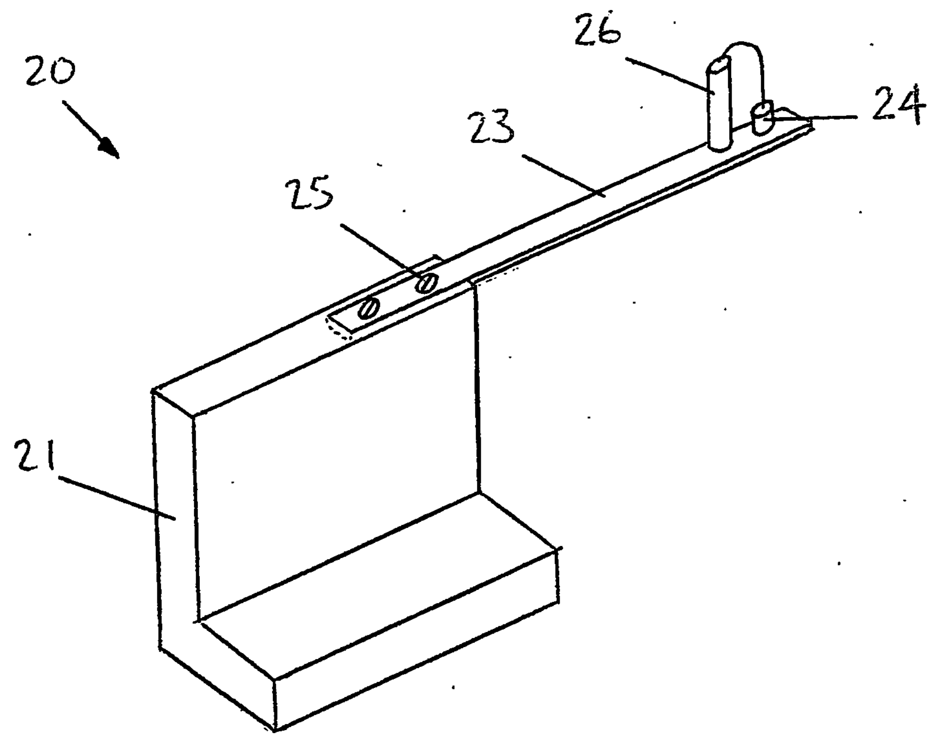

Figure 3

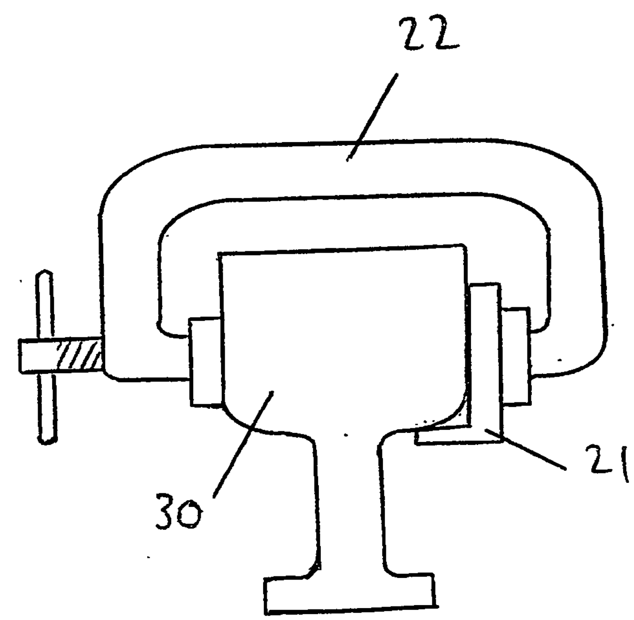

Figure 4